Discrete Math Topics

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Office hours: By appointment. I am available after school on most days.

Course Description: This class is an exploration of several practical mathematical applications. It is intended to provide students with an understanding and appreciation for the many areas of life that can be analyzed mathematically. The course will be divided into nine chapters:

Chapter 1: Voting (different methods, fairness criteria)

Chapter 2: Weighted voting systems (distributing power, different power indices)

Chapter 3: Fair distribution (divider-chooser methods, dividing discrete objects)

Chapter 4: Apportionment (number of seats in House of Representatives, different methods of rounding shares of seats)

Chapter 5: Euler circuits (finding the most efficient path through an Euler circuit)

Chapter 6: Hamilton circuits (finding the most efficient path through a Hamilton circuit, semi-optimal algorithms)

Chapter 7: Networks (minimal spanning trees, networks of more than 3 points)

Chapter 8: Scheduling (directed graphs, critical paths)

Chapter 9: Fractals (Koch snowflakes, Sierpinski triangles)

Textbook & Required Material: We do not have a book for this class. All of the content will be in the class notes, and problem sets will be provided by me. We will be using the TI-83 calculator on occasion in this class, so make sure that you have it with you for every class period.

Course Goals & Benchmarks:

Discrete Math Topics
Benchmarks and Performance Standards

Students completing course work in discrete math topics will:

- Understand the importance and relevance of election theory.
- Produce a preference schedule from preference ballots.
- Determine the winner of an election using the plurality method, the Borda count method, the plurality with elimination method, and the method of pair wise-comparisons.
- Use extended methods to rank the candidates in an election.
- Evaluate the voting methods using the standards of fairness: Majority Criterion, Condorcet Criterion, Monotonicity Criterion and Independence -of -Irrelevant Alternatives Criterion.
- Understand Arrow's Impossibility Theorem.
- Identify players that are dictators, dummies, or have veto power.
- Distinguish between winning and losing coalitions.
- Distinguish between critical players and pivotal players.
- Compute the Banzhaf Power Distribution of a weighted voting system.
- Compute the Shapley-Shubik Power Distribution of a weighted voting system.
- Identify fair shares using a given value system.
- Apply continuous division algorithms.
- Calculate a fair estate division among heirs using the method of sealed bids.
- Apply the method of markers.
- Understand the historical and current significance of apportionment.

- Use the methods of Hamilton, Jefferson, Adams, Webster and Huntington-Hill to apportion seats in a representative body.
- Apply apportionment to other appropriate problems.

- Understand the quota rule and the paradoxes of proportional representation.
- Understand the application of circuits to routing problems.

- Distinguish between a path and a circuit.

- Model a routing problem using a graph.

- Analyze graphs and determine Euler paths or Euler circuits.

- Find an optimal eulerization or semi-eulerization for graphs.

- Understand and identify a Hamilton circuit/path.

- Find the most efficient Hamilton circuit/path using the brute force, nearest neighbor, and cheapest link algorithm.

- Understand and identify a spanning tree.

- Use Kruskal's algorithm to find the minimal spanning tree.

- Use a Steiner point to find the shortest distance between 3 points.

- Read and create a directed graph for a work schedule.

- Understand precedence relations and priority lists for work schedules.

- Use the backflow and critical path algorithms to find an optimal work schedule.

- Be able to draw the first several iterations of a Koch snowflake.

  Be able to draw the first several iterations of a Sierpinski triangle.

Grading policy: Your grade for the class will be (approximately) 40% chapter tests, 25% final, 20% quizzes, and 15% homework. The grading scale is the standard 90-80-70-60 scale. Homework will be assigned on a regular basis, and checked periodically. Homework should be organized, legible, and should demonstrate that some time and

effort was put into it. I will occasionally collect a homework assignment and grade it for credit; I will let you know when I want to do this. If you are absent on the day that I collect an assignment, it is your responsibility to turn it in when you return.

We will have a quiz and a test over every chapter and a final at the end of the semester. Ordinarily, if you miss a quiz or a test due to absence, you will make it up on the day that you return (I strongly prefer that tests and quizzes NOT be made up during class time, so if you miss a test or quiz, plan on coming in early or staying after school to take it the next day). However, if you are absent for several days, we can make arrangements when you get back. If you know in advance that you will be absent on the day of a quiz or a test, talk to me and we will try to work something out.

General Classroom Expectations: The school policy on absences and tardies can be found in the student handbook. If you are absent from class, it is your responsibility to get the notes and any homework assignments from that day. When you are absent, please check the website for any homework assignments and upcoming quizzes/tests. When in class, you will conduct yourself with the honor and dignity that is expected of an Immaculate Heart student. This means that, among other things, you will pay attention, not create distractions for yourself or others, and always adhere to the academic integrity code of this school.